DOCUMENT RESUME

ED 275 221 HE 019 665

AUTHOR Ellis, Susanne D.
TITLE Graduate Student Survey, 1984-85. AIP Report.
INSTITUTION American Inst. of Physics, New York, N.Y. Manpower Statistics Div.
REPORT NO AIP-R-207-18
PUB DATE Aug 86
NOTE 14p.
AVAILABLE FROM American Institute of Physics, 335 East 45 Street, New York, NY 10017.
PUB TYPE Statistical Data (110) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Astronomy; *Degrees (Academic); Doctoral Degrees; *Employment Opportunities; Enrollment Trends; Foreign Students; *Graduate Students; Higher Education; Masters Degrees; Minority Groups; National Surveys; *Physics; Salaries; Specialization; *Student Characteristics

ABSTRACT

Results of the 1984-1985 Graduate Student Survey of physics and astronomy graduates are presented, with attention to: educational background, current graduate student status, choice of subfield, and employment prospects. Highlights include: a major increase occurred in the proportion of foreign physics doctorate recipients; the number and percentage of theoreticians and postdoctoral students increased; and there was a greater demand for master's level physicists. Information is provided on eight characteristics for the total graduate population including seven minority groups, and for three subgroups: first-year graduate students, terminal masters, and doctoral recipients; the characteristics are: sex, citizenship, whether physics was studied in high school, major of bachelor's degree, type of bachelor's institution, type of graduate institution, full-time or part-time attendance, and sources of financial support. Additional tables in include: number of advanced graduate physics students specializing in experimental and theoretical subfields by years of graduate study completed; type of employers and work activity of 1984-1985 physics master's and doctoral degree recipients; the number and percent of astronomy graduates students studying selected subfields, and characteristics of the graduate astronomy student population. (SW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED275221

AIP REPORT Manpower Statistics Division

American Institute of Physics, 335 East 45 Street, New York, N.Y. 10017 (212) 661-9404

1984-85

GRADUATE STUDENT SURVEY

---

by Susanne D. Ellis AIP Pub. No. R-207.17 August, 1986

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Susanne D. Ellis

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

HE 019 665

AIP report MANPOWER STATISTICS DIVISION

American Institute of Physics, 335 East 45 Street, New York, N.Y. 10017 (212) 661-9404

1984–85 GRADUATE STUDENT SURVEY

by Susanne D. Ellis

AIP Pub. No. R-207.18 August, 1986

For twenty-five years, with the help of physics department chairpersons, we have examined the educational backgrounds and employment opportunities of physics graduate students. In the mid-1970's this annual survey was expanded to include graduate astronomy students who comprise less than 10% of the physics population. All the information gathered in this survey is contributed by individual graduate students, and the data are analyzed so as to call attention to changing trends. Along those lines, the most influential change is the steady increase in foreign graduate physics students since the late 1970's. The far-reaching effects of this change are discussed in detail in the first ten pages of this report, leaving the last two pages for an analysis of the graduate astronomy population. Highlights of this report are:

- a major increase in the proportion of foreign physics doctorate recipients.
- related to the above, an increase both in number and percentage of theoreticians and postdocs.
- a greater demand for master's level physicists.

As queries regarding the demand for new physicists continue to dominate the requests for information, we find that analyzing the number of job offers graduates receive is a useful method of dealing with so complex a topic. **Figures I** and **II** present such analyses and cover the five-year period from 1980–1985. For each of the two groups of graduate degree recipients the numbers of employment offers are divided into three categories: no offer, one offer and multiple offers. Thus **Figure I** can be interpreted as showing a high demand for new doctoral physicists because over 95% of them reported employment offers at the time their degrees were conferred, and a majority of that group had received multiple offers to choose from. The demand for new physics masters is not as high but shows a substantial improvement for the most recent graduates. The percentage of new physics masters without job offers right after graduation fell below 10% for the first time since the early 1970's when we introduced that question on our graduate student forms. **Figure II** also shows a five percentage-point increase over the previous year for masters who reported multiple employment offers during the most recent year.

Table I presents eight characteristics of the total graduate physics student population as well as those of three subgroups, namely the first-year students, the terminal masters and the doctorate recipients. Our annual Survey of Enrollments and Degrees establishes the total population in each of these groups, forming a base for interpreting the responses to the Graduate Student Survey. The first two rows of **Table I** present these numbers.

Despite efforts to encourage more women to become physicists, their proportion among the graduate physics student population increases only very gradually. The entering graduate students in 1984–85 included 13% women, a proportion that indicates a one percentage-point increase over the previous year. Naturally, so small an increase did not affect

Figure I. Employment offers for new physics doctorate recipients, 1980–85.

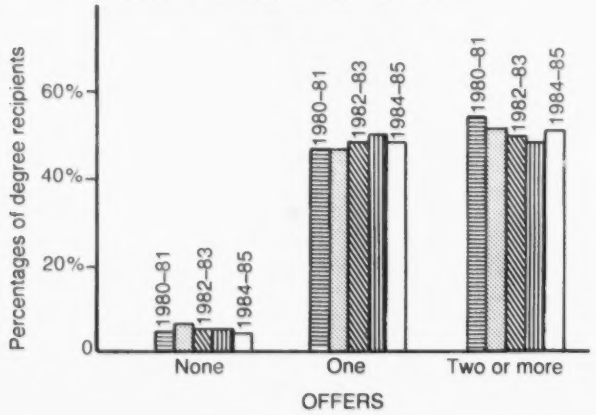
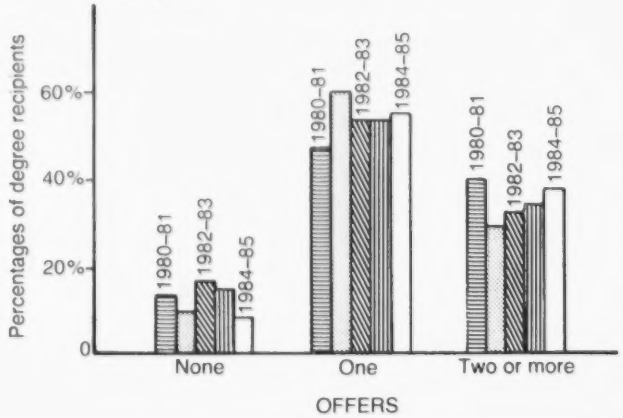


Figure II. Employment offers for new masters, 1980–1985



MEMBER SOCIETIES:
AMERICAN PHYSICAL SOCIETY • OPTICAL SOCIETY OF AMERICA • ACOUSTICAL SOCIETY OF AMERICA • SOCIETY OF RHEOLOGY • AMERICAN ASSOCIATION OF PHYSICS TEACHERS • AMERICAN CRYSTALLOGRAPHIC ASSOCIATION • AMERICAN ASTRONOMICAL SOCIETY • AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE • AMERICAN VACUUM SOCIETY • AMERICAN GEOPHYSICAL UNION

Table I. Characteristics of the graduate physics student population, 1984–85.

Characteristics		All graduate students	First-year graduate students	Degree recipients: Terminal masters	Degree recipients: Doctorate recipients
	*Total population:	11337	2863	629	972
	Number of respondents	6525	1303	269	605
Sex	Female	12%	13%	*13%	*8%
	Male	88	87	87	92
Citizenship	U.S.	*64%	*61%	80%	69%
	Foreign	36	39	20	31
Physics in High school	Yes	92%	91%	83%	94%
	No	8	9	17	6
Major of bachelor's degree	Physics	90%	87%	82%	92%
	Mathematics	2	2	3	3
	Engineering	4	5	7	2
	Other phys. science	2	3	4	2
	Other	2	3	4	1
Type of bachelor's institution	PhD-granting	46%	39%	42%	51%
	MS-granting	7	7	14	7
	BS/BA-granting	17	19	31	16
	Foreign	30	35	13	26
*Type of graduate institution	PhD-granting	91%	85%	75%	100%
	MS–granting	9	15	25	--
*Student status	Full-time	90%	90%	79%	93%
	Part-time	10	10	21	7
Source of support	Teaching assistantship	33%	53%	41%	12%
	Research assistantship	44	15	17	68
	Fellowship	7	10	6	7
	Employment (part-time)	2	3	5	3
	Family, savings, loan	3	5	4	3
	Other**	11	14	27	7

These data were derived from the Survey of Enrollments and Degrees.
**Includes full-time employment for part-time students.*

the total graduate population, which remained at the 12% level shown in **Table I**.

The characteristic that has indicated steady increases since the late 1970's is citizenship. Entering graduate physics students from foreign countries nearly doubled their numbers between 1978–79 and 1984–85 thereby increasing their proportions almost annually in each of the four groups presented in **Table I**. As foreign physics students are beginning to emerge from the educational pipeline, they accounted for the largest increase between 1984 and 1985 of foreign doctorate recipients. **Table I** indicates that 32% of the respondents were foreign citizens; this represents a seven percentage-point increase over the previous year.

By comparing the distribution of students in the three subgroups of **Table I** with the total graduate physics student population for each of the characteristics, we find that significant differences occur only among the terminal masters. Citizenship, high school physics, type of graduate institution and student status are examples of this pattern. The reasons for this non-conformity can be attributed to their low identification rate with the physics profession which in turn accounts for their consistently low response rate to surveys of physics students.

Traditionally, beginning graduate students are offered teaching assistantships until they advance enough to qualify as research assistants. Funds for assistantships in physics have always been plentiful, which is indicated in **Table I** by the small proportion of graduate students who are obliged to use family funds and loans or resort to part-time off-campus employment at any level of study. For more detailed information on sources of support, see **Table IV**.

Almost one-third of the graduate physics students identify themselves as members of a specific minority group, but only about 12% of them are U.S. citizens. **Table II** lists the minority groups and divides the larger ones on the basis of citizenship; Asian Indians and Arabs are predominantly foreign. Six characteristics in addition to citizenship are presented in **Table II** so as to facilitate comparisons between specific minority groups and the graduate physics population as a whole. For example, by singling out the foreign minorities we find: 1. They are more likely to have studied physics before entering college, and 2. they are less likely to terminate their studies at the master's level. The fifth characteristic listed in **Table II** indicates levels of graduate study where an even distribution of students for the first five years points to a low attrition; Arabs and Asian Indians are examples of this phenomenon. Orientals too have a low attrition but their rapid annual increases tend to obscure patterns that would otherwise be easily identifiable.

The last two rows of **Table II** indicate the number of degree recipients in each minority group for 1984–85. The numbers should be viewed as lower limits because they represent individual respondents to a survey whose overall response is

Table II. Characteristics of minority group physics students, 1984–85.

Characteristics		Black U.S.	Black Foreign	American Indian	Hispanic Puerto Rican	Hispanic Mexican American	Other U.S.	Other Foreign	Asian Indian	Oriental U.S.	Oriental Foreign	Arab
	Total number:	42	35	12	18	16	44	115	374	101	1149	180
Sex	Female	8	3	3	6	2	6	15	70	16	159	16
	Male	34	32	9	12	14	38	100	304	85	990	164
Candidacy for:	TMS	8	8	3	3	2	4	5	22	9	53	14
	MS and PhD	27	25	6	13	9	24	77	295	66	699	138
	PhD only	7	2	3	2	5	16	33	57	26	397	28
Student status	Full-time	34	34	11	16	14	43	111	366	91	1119	169
	Part-time	8	1	1	2	2	1	4	8	10	30	11
Physics in high school	Yes	33	31	8	17	14	38	112	361	94	1111	176
	No	9	4	4	1	2	6	3	13	7	38	4
Full-time equivalent years of graduate study	≤1	14	7	3	2	7	16	27	51	25	228	22
	2	10	11	4	4	2	9	19	76	25	263	34
	3	5	6	1	–	4	8	23	60	14	219	25
	4	7	3	1	5	1	5	20	71	12	184	30
	5	3	5	1	1	–	2	14	57	12	162	23
	6	3	3	1	1	1	2	6	25	6	47	22
	>7	–	–	1	5	1	2	6	34	7	46	24
Major subfields	Elect. at. mol.	1	1	3	0	1	1	10	25	6	90	11
	Elem. particles	2	3	1	1	1	8	14	51	11	105	15
	Math. physics	4	0	0	0	0	5	15	20	7	59	12
	Nuclear	5	4	1	1	2	6	9	37	8	60	25
	Optics/hol.	9	3	0	1	2	4	5	19	8	90	16
	Solid state	15	11	5	10	4	10	37	144	31	538	60
Graduate degree recipients	TMS	10	2	1	3	0	1	2	7	6	28	7
	Doctorates	6	2	2	1	0	3	11	38	5	83	15

less than 60%. Black degree recipients are the exception because physics department chairpersons are asked to report the numbers of black graduates as part of the Survey of Enrollments and Degrees, thereby improving the accuracy of those tables.

In a comparison with earlier years we note that for two years in a row over 10% of all physics doctorates were conferred on foreign Orientals. The number of Arabs, on the other hand, continues to decline; this trend is evident among all graduate students as well as degree recipients.

The data in **Table III** were scaled up to give an estimate of the total number of graduate physics students in each of the major subfields and at nine levels of graduate study. One reason for presenting this type of analysis is to make it possible to estimate the number of graduates in a given subfield who will seek employment within a year or two. Approximately two years of graduate study are required for a terminal master's degree and at least five or six years for a doctorate. Thus **Table III** serves the additional purpose of indicating which subfields are likely to require more time to complete a dissertation. Both nuclear physics and electron, atomic or molecular physics appear to be examples of such a specialty. By comparing the percentages in the last column with those of earlier years we find that the additional graduate students enrolling each year appear to choose subfields in the same proportions as their predecessors.

Table III. Number of graduate physics students, by subfield and years of graduate study completed, 1984–85.

		Full-time equivalent years of graduate study									Total graduate students	
		≤ 1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs	6 yrs.	7 yrs.	8 yrs.	>9 yrs.	N	%
Distribution* of students	N	2863	2222	1745	1620	1360	814	373	215	125	11337**	
	%	25.2	19.6	15.4	14.3	12.0	7.2	3.3	1.9	1.1		100%
Astrophysics		174	136	59	87	91	40	15	17	5	624	5.5
Bio/medical physics		106	82	33	41	39	19	10	5	5	340	3.0
Electron, atomic, molecular		207	160	148	141	91	77	35	24	13	896	7.9
Elem. particles		378	264	248	204	160	112	49	26	10	1451	12.8
Geo/atmospheric physics		77	77	73	68	41	29	21	15	7	408	3.6
Mathematical physics		183	124	129	113	93	44	23	8	8	725	6.4
Nuclear physics		226	165	147	141	149	85	34	26	13	986	8.7
Optics		248	173	88	57	50	33	10	9	2	670	5.9
Plasma/fluid physics		117	102	89	94	88	37	32	17	2	578	5.1
Solid state		806	714	624	611	486	277	137	65	55	3775	33.3
Other subfields		341	225	107	63	72	61	7	3	5	884	7.8

* *The distribution of students in each subfield is based on 6525 respondents to this question.*

** *The total was derived from the Survey of Enrollments and Degrees.*

Table IV. Sources of support for graduate physics students, by sex and degree status, 1984–85.

Source of support		Female	Male	Candidates for: Terminal master's	Master's enroute to PhD	PhD after master's	PhD only	Total N	Total %
Teaching assistantship		37%	34%	43%	46%	26%	35%	2232	34
Research assistantship		38	45	13	29	56	49	2871	44
Fellowship		8	7	4	6	7	10	470	7
Foreign government		2	2	3	3	2	2	124	2
Family, savings, loan		4	3	6	5	2	2	183	3
Part-time employment		2	3	5	3	2	1	157	2
Other, including multiple sources of support		9	6	25*	8	5	1	488	8
		100%	100%	100%	100%	100%	100%		
Total respondents	N	793	5732	613	1344	2595	1973	6525	
	%	12	88	9	21	40	30		100%

* *Includes masters who worked full-time to support their graduate studies.*

Adding to the discussion of the sources of support presented in connection with **Table I**, we show in **Table IV** how candidacies for specific degrees determine the type of support available to students. For example, master's degree candidates are likely to be offered teaching assistantships whereas research assistantships are more prevalent among the advanced students. Foreign citizenship does not appear to prevent graduate students from acquiring teaching or research assistantships. This observation is based on the fact that 36% of the students are foreign citizens, and only 2% of them reported financial support from foreign governments.

As long as a higher proportion of women than men are terminal master's rather than doctoral candidates the percentage of women holding teaching assistantships will be greater than that for men. In the province of the advanced graduate student where research assistantships are most common the difference is even more pronounced. Only 38% of the women graduate students are research assistants compared with 45% of the male students.

Table V. Number* of advanced graduate physics students specializing in selected experimental or theoretical subfields by years of graduate study completed, 1984–85.

Physics subfield	Type of research	Full-time equivalent years of graduate study. 3 yrs.	4 yrs.	5 yrs.	6 yrs.	7 yrs.	8 yrs.	>9 yrs.	Total N	% Exp.	% Theo.
Astrophysics	experimental	35	55	34	27	9	11	2	173	4.1	
	theoretical	18	34	55	9	7	7	4	134		6.5
Bio/medical	experimental	23	32	34	23	9	4	5	130	3.1	
Electron, atomic molecular	experimental	125	98	75	57	27	25	12	419	10.0	
	theoretical	28	48	18	18	7	5	2	126		6.1
Elem. particles	experimental	144	120	91	87	41	21	9	513	12.2	
	theoretical	101	91	64	30	11	4	2	303		14.6
Math. physics	theoretical	119	108	91	45	21	9	7	400		19.3
Nuclear	experimental	91	98	117	69	28	23	11	437	10.4	
	theoretical	55	48	41	16	5	4	–	169		8.2
Optics	experimental	87	41	42	25	5	5	2	207	5.0	
Plasmas	experimental	58	46	48	12	16	5	2	187	4.5	
	theoretical	34	48	43	25	14	13	–	177		8.6
Solid state	experimental	440	451	374	213	118	57	44	1697	40.6	
	theoretical	160	153	107	60	23	7	5	515		24.9
Other subfields	experimental	133	99	85	69	21	5	9	421	10.1	
	theoretical	77	66	43	35	10	10	3	244		11.8
Total	experimental	1136	1040	900	582	274	156	96	4184	100.0%	
	theoretical	592	596	462	238	98	59	23	2068		100.0%

* *The numbers in this table have been scaled up to reflect the total number of graduate students (6252) who completed three or more years of graduate study.*

Table VI. Distribution by subfield and employment offers for doctorate recipients, 1984–85.

Physics subfield		Total in subfield	Employment-oriented graduates	New 'postdocs'	Percentage of graduates within subfield received: 0 offer	1 offer	≥2 offers
Astrophysics		6.1%	1.9%	4.2%	6%	45%	49%
Electron, atomic molecular		7.4	4.1	3.3	5	59	36
Elem. particles		15.3	4.6	10.7	5	37	58
Geo./Geophysics		4.1	1.7	2.4	5	52	48
Math. physics		5.4	2.0	3.4	6	60	38
Nuclear		11.6	3.7	7.9	3	45	53
Optics		2.4	1.5	0.9	7	40	53
Plasmas, fluids		7.0	4.6	2.4	–	37	63
Solid state		34.4	19.3	15.1	2	41	49
All other subfields		6.3	3.8	2.5	5	51	40
Total	%	100.0%	49.7%	50.3%	3%	47%	50%
	N	943*	469	474			
All experimental subfields			359	293	3%	48%	49%
All theoretical subfields			110	181	4	45	51

* *This total does not include an estimated 29 graduates who were not interested in immediate employment, (see Figure IV). It is the Survey of Enrollments and Degrees which supplied this total.*

The normal pattern of graduate education in physics consists of two years of course work followed by three or four years of research in an area of concentration which leads to a doctoral dissertation. The intensive professional work, which usually starts in the third year of graduate school, is performed either on an experimental or theoretical basis. An array of doctoral candidates, grouped by type of research, subfield and level of graduate study, is presented in **Table V**. The ratio of experimentalists to theoreticians remains at 2:1 although a gradual increase in theoreticians becomes noticeable as the proportion of foreign students increases from year to year.

Degree recipients

Having achieved a high level of specialization in both a physics subfield and a research method, new doctoral physicists need to choose between two types of employment: a temporary postdoctoral fellowship or a potentially permanent position. Disregarding for the moment the complications that arise from foreign citizenship, the graduates' employment choices are largely based on the extent to which their physics education can be utilized. **Table VI** relates the two types of initial employment and the number of job offers to each of the major subfields and points to a very favorable job market. Only 3% of the doctorate recipients were without immediate offers but 50% had multiple offers to choose from.

By comparing the temporary versus permanent types of initial employment in **Table VI** with the choices made by previous classes of graduates, we find a steady shift towards 'postdocs' from 38% in 1981 to over 50% in 1985. The two factors that may contribute to this shift are: (1) the increase in foreign graduates whose visas limit their employment to temporary 'postdocs', and (2) an improving job market that makes new physicists confident about securing permanent employment one or two years later while they use a 'postdoc' to continue the research of their dissertations. However, both factors are influenced by the declining number of new U.S. doctorate recipients.

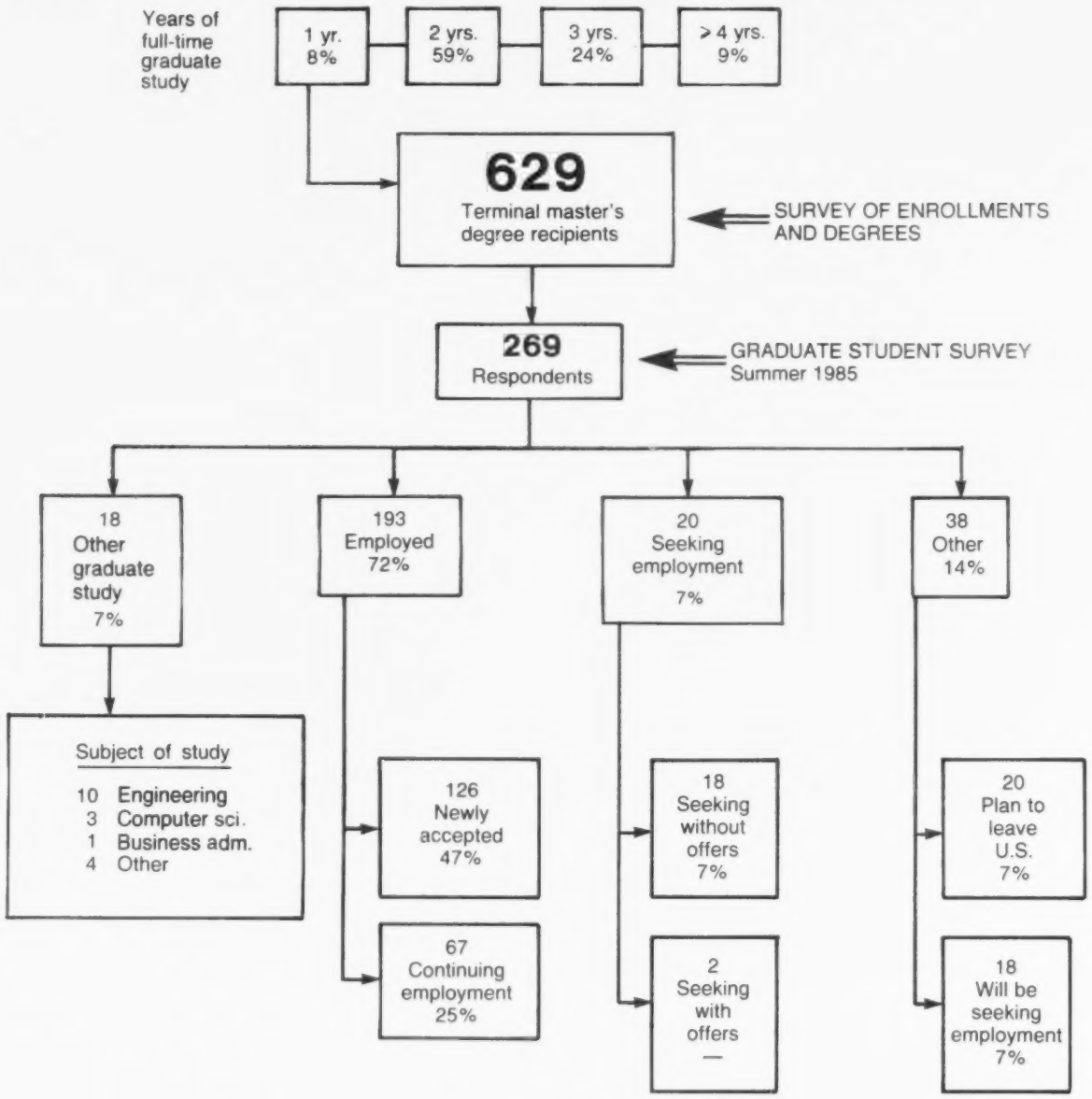
A broader view of the demand for physicists should include employment opportunities both in the United States and abroad. The analysis presented in **Table VII** is designed to focus on that type of exchange, namely what proportion of foreign graduates remain in the U.S. for their initial employment while U.S. citizens with new physics doctorates go abroad to accept their first postdoctoral positions. By singling out the employment-oriented graduates in **Figure IV** for inclusion in **Table VII**, we find that one-third are foreign citizens and that 73% of these new foreign physicists began employment in the U.S., but only one in four accepted a potentially permanent position. In 1980, only 61% of the corresponding group of foreign doctorate recipients remained in the U.S. for their initial employment. The proportion of U.S. graduates who chose foreign employers also increased since 1980; they rose from 3% to 10%.

Table VII. Employment of doctoral graduates by citizenship, 1984–85.

Doctoral graduates		U.S. employer 'Postdoc'	U.S. employer Accepted	U.S. employer Cont.	Foreign employer 'Postdoc'	Foreign employer Accepted	Uncommitted	Total N	Total %
U.S. citizens		159	154	25	19	6	20	383	67
Foreign citizens		105	33	2	12	32	5	189	33
Total	N	264	187	27	31	38	25	572	
	%	46	33	5	5	7	4		100%

Note: 15 respondents did not report sufficiently detailed employment data for inclusion in this table.

Figure III. Post-degree plans of physics terminal master's degree recipients, 1984–85



As long as the demand for physicists remains high, physics students who decide to terminate their graduate studies at the master's level will be more likely to start employment than to continue graduate work in another discipline. **Figure III** reflects this assessment because the proportion of masters who are interested in "other graduate study" is only 7% and represents a continuing decline with respect to past years. For example, in the class of 1980, 16% of the new physics masters changed disciplines and continued their graduate studies. Also noteworthy is that this group of 18 respondents includes eleven foreign citizens. Examining how the selection of other "subjects of study" has changed over the years, we note that only the potential engineering students remain undiminished; physics students interested in changing to the life sciences or to business studies probably make that change at the bachelor's level rather than after completing several years of graduate study in physics.

According to the characteristics table over 20% of the physics masters were part-time students who financed their graduate studies by means of full-time employment. Many of these masters subsequently remained with the same employers after graduation. **Figure III** classifies this group as "continuing employment," and it comprises one-quarter of all the respondents.

Table VIII. Distribution, by subfield, of employment offers for terminal masters, 1984–85.

Physics subfield	Total in subfield*	Percentage of graduates within subfield received: 0 offer	1 offer	≥2 offers
Electron, atomic, molecular	9.2%	5%	55%	40%
Engr. and applied physics	8.4	5	47	48
Geo./space physics	4.2	–	78	22
Nuclear	9.2	–	75	25
Optics, lasers	11.5	8	58	34
Plasma/fluids	5.3	9	55	36
Solid state	28.4	16	40	44
General physics	5.4	12	50	38
All other subfields	18.4	6	59	35
Total	100.0%	9%	53%	38%
Employment-oriented respondents	211	18	112	81

* *Based on 269 respondents.*

Masters with newly accepted positions form the largest group shown in **Figure III** and include 14 positions with foreign employers; only two of those represent U.S. citizens who accepted initial employment abroad. The group of 20 masters who "plan to leave the U.S." are all foreign graduates.

There has been a substantial decline in the number of new physics masters seeking employment at the time of this survey. In part, the improved employment outlook can be attributed to changes in the expectations of terminal masters, or that employers offer more attractive positions to them. The 7% indicated in **Figure III** as "Seeking without offers" represents a four percentage-point decline from the previous year. The proportion of graduates who reported no immediate employment plans remained fairly constant.

For the 211 employment-oriented masters **Table VIII** presents additional details on major subfields and employment offers. The 18 new masters who were identified in **Figure III** as "seeking without offers" comprise 9% of this group. Most of the decline from the previous year in the "zero offer" category produced a corresponding increase among the physics masters with multiple offers.

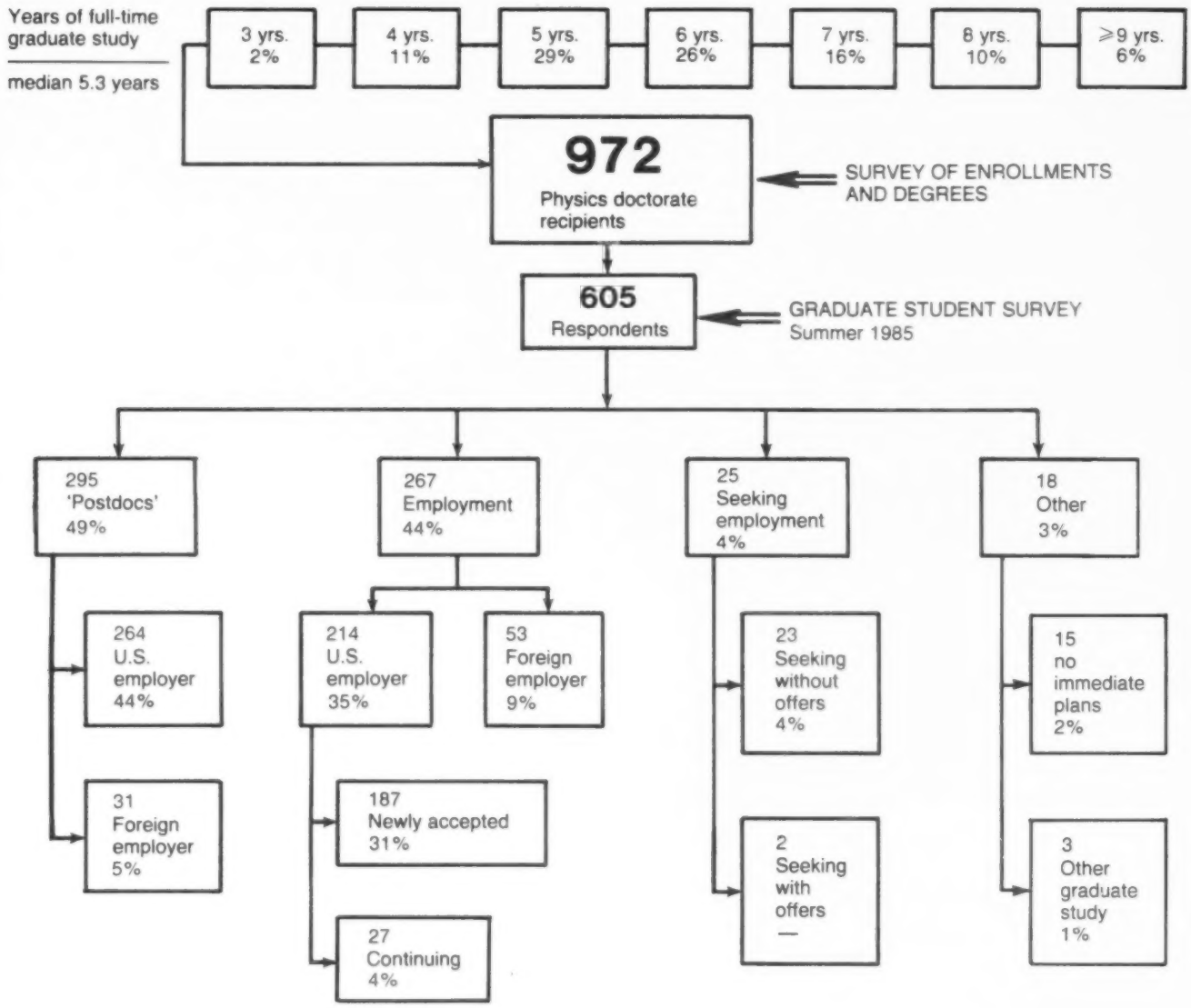
There is a tendency for physics masters to choose the more applied subfields such as optics or engineering physics; however, the respondents in the class of 1985 included an increase among those whose concentration was nuclear physics and **Table VIII** indicates that the nuclear physics masters reported at least one employment offer each.

While not all of the 193 masters who received employment offers began to work immediately, 185 of them were in a position to describe their work activities and identify their types of employers. As in past years industry remains the largest single employer where new masters perform engineering tasks as well as research and development activities. The types of employers listed in **Table IX** distinguish between the military and civilian government agencies because the graduates perform different functions for these two employers. "Nonphysics professional work" is the way we interpret the responses from masters who joined the military, whereas civilian government employers are more research oriented. The number of new masters who go into secondary school teaching has reached an all-time low of three respondents who are grouped with six 2-year and 4-year college teachers in **Table IX**.

Table IX. Employment characteristics of 1984–85 recipients of master's degrees.

Work activity		Type of employer: Univ.	Other ed. inst.	Industry	Gov't.	Military service	Nonprof. org.	Total N	Total %
Teaching		8	8	–	3	1	–	20	11
Research		7	–	7	11	–	1	26	14
Res. and dev.		1	1	39	7	7	3	58	31
Engineering		1	–	45	5	–	–	51	28
Comp. science		–	–	5	2	–	1	8	4
Nonphy. prof. work		3	–	6	–	12	1	22	12
Total	N	20	9	102	28	20	6	185	
	%	11	5	55	15	11	3		100%

Figure IV. Background characteristics and post-doctorate status of 1984–85 physics graduates.



The flow diagram of **Figure IV** summarizes parts of the data presented in **Tables I, VI,** and **VII** by focusing on the physics doctorate recipients of 1984–85. The wide range in the number of years required to complete a physics Ph.D. reflects the diversity of doctoral candidates at U.S. universities. Foreign students, some of whom enter at advanced levels of study, are not the only contributors to this diversity; since undergraduate programs at U.S. colleges and universities range widely in quality, graduates from some of the less demanding programs require additional years of graduate study. The major change in post-degree status involves the steady decline in the number of new doctoral physicists available to fill potentially permanent positions in the U.S. The increasing proportion of foreign graduates is partly responsible for this trend. Other contributing factors include the attractiveness of postdoctoral fellowships that tempt new degree recipients who are confident that the employment outlook will become more favorable as the 1990's approach. Specifically, **Figure IV** shows 35% of the new physicists accepting potentially permanent employment in the U.S. which represents a change from 51% five years earlier.

Table X. Use of physics in potentially permanent employment of graduate degree recipients, 1984–85.

	Major employer	Extensive use of physics training with respect to: method	subject matter	Number responding to question
Doctorate recipients	University	84%	78%	32
	Industry	82	62	114
	FFRC	95	79	19
	Government	89	82	18
	All Employers:	86%	70%	222

		Use of physics training with respect to subject matter: Extensive	Little	None	Number reporting
Terminal masters	Educational inst.	79%	18%	3%	28
	Industry	57	38	5	102
	FFRC/Gov't.	52	40	8	48
	All Employers	59%	36%	5%	187

New physicists, whether at the doctoral or master's level, are concerned about the extent to which their initial employment utilizes their physics training. **Table X** summarizes the responses from 222 doctoral and 187 master's graduates who had accepted potentially permanent positions. For each of the major types of employers listed, a larger proportion of doctoral physicists makes extensive use of the research methods they were taught than of the subject matter of their subfields.

Few masters have had the time in graduate school to develop research methods; consequently it is more meaningful to examine the extent to which an employer utilizes the subject matter of a new master's level physicist. Educational institutions always rank highest among the employers who make extensive use of a graduate's training but industry is the employer on whom attention should be focused because it employs more masters than all other employers combined. Since 1981, when only 38% of the new physics masters reported extensive use of their training, significant changes occurred. It appears that industrial employers offer more suitable positions to physics masters, so that 57% of the 1985 graduates evaluated their work as making extensive use of their areas of concentration.

To examine further the utilization of a physics education, we focus on the work activities of doctorate recipients who accepted potentially permanent positions. **Table XI** lists the traditional work activities along with engineering and relates them to the major employers. Thus we find that in ten years the proportion of new physicists who start work in industry has doubled while university positions decreased to half of their proportion recorded in 1974–75. Work activities indicated a corresponding shift toward research and development and away from teaching.

Table XI. Initial employment with potential permanence for 1984–85 physics doctorate recipients.

Work activity		Type of employer: University	Coll.	Industry	FFRC	Gov't	Other	Total N	Total %
Teaching		3	11	1	–	–	–	15	7
Research		10	–	21	9	12	4	57	26
Res. and teaching		18	11	1	–	–	–	29	13
Res. and dev.		5	–	65	9	4	3	86	40
Engineering		–	–	17	–	1	–	18	8
Other		–	–	8	1	1	2	12	6
Total	N	36	22	113	19	18	9	217*	
	%	17	10	52	9	8	4		100%

** Of the 240 doctorate recipients (see Figure IV) 23 did not specify both work activity and type of employer.*

Table XII. Median monthly starting salaries paid by U.S. employers to new physics degree recipients, 1985.

Type of Employer	Bachelor's degree recipients		Terminal master's degree recipients		Doctorate recipients			
	Percentage accepting positions	Monthly starting salaries	Percentage accepting positions	Monthly starting salaries	Percentage accepting: 'Postdocs'	Potentially perm. pos.	Monthly starting sal. for 'Postdocs'	Potentially perm. pos.
Secondary school	4%	$1270	2%	*	–	–	–	–
College	3	1420	3	$1850	–	5%	–	$2000
University			11	1580	41%	6	$1820	2400
Industry	55	2190	55	2560	4	24	3050	3375
Gov't. inc. mil.	34	1550	22	2200	3	3	2150	2550
Fed. Funded Res. Ctr.	3	2200	4	2300	7	4	2175	3550
Other	1	1610	3	2250	1	2	2200	3180
All employers	100%	$1990	100%	$2400	100%		$1895	$3120

* *Insufficient data.*

Starting salaries presented in **Table XII** include only those paid by U.S. employers for newly accepted positions. Hence the 39 physicists shown in **Figure IV** as "continuing" the employment they held while completing their doctorates are not included. Doctoral physicists are divided into two groups because those starting potentially permanent employment are paid significantly higher salaries than those who accepted postdoctoral fellowships. For purposes of comparison, the starting salaries of physics bachelors were included in **Table XII** although they are not collected as part of the Graduate Student Survey. Thus the four salaries shown for the three levels of physics degree recipients continue to place 'postdocs' and regularly employed doctoral physicists at opposite ends of the salary scale.

Although industrial employers continue to pay some of the highest starting salaries, the highest median salary in 1985 was paid by the Federally Funded Research Centers. Increases over the previous year amounted to 6% for the bachelors and the 'postdocs', whereas masters and doctors in potentially permanent positions recorded 2% and 3% respectively.

ASTRONOMY

Forty-six universities in the U.S. enroll the entire graduate astronomy population, which stabilized around the 700 level in 1980, and, based on the number of first-year students, is not expected to increase in the near future. Each year the graduate astronomy students are asked to contribute information to this survey which is presented in two tables and a flow diagram in this report. **Table XIII** relates the levels of graduate study to the major subfields in astronomy which include astrophysics, a

Table XIII. Graduate astronomy students* by subfield and years of graduate study 1984–85.

	Full-time equivalent years of graduate study						Total	
	1 yr.	2 yrs.	3 yrs.	4 yrs.	5 yrs.	>6 yrs.	N	%
Distribution of students N	145	128	137	107	96	103	716	
%	20%	18%	19%	15%	13%	15%		100%
Astronomy subfields								
Astronomical instruments and techniques	5%	6%	4%	5%	4%	2%	32	4%
Cosmology, extragalactic objects, quasi-stellar objects	29	21	23	30	31	23	185	26
Galactic structure, stellar motions	9	6	8	9	8	2	51	7
Interstellar matter and gaseous nebulae	14	8	19	14	17	20	109	15
Solar system, space astronomy of the solar system	7	3	11	2	10	7	47	7
Stellar atmospheres and spectra, stellar evolution, solar and stellar interiors	10	21	17	28	20	18	133	19
Supernovae, X, γ and cosmic rays, pulsars	1	2	4	5	–	5	21	3
The sun	–	5	3	4	6	7	26	4
Astrophysics	13	17	9	2	4	9	67	9
All other subfields combined	12	11	2	1	–	7	45	6
	100%	100%	100%	100%	100%	100%		

**The percentages shown in this table are based on 406 respondents to the Graduate Student Survey. Astronomy department chairpersons reported a total of 716 graduate students as part of the Survey of Enrollments and Degrees.*

subfield also listed among the physics subfields. By far the largest subfield is cosmology followed by stellar atmospheres and interstellar matter.

A majority of the graduate astronomy students share a common origin with their physics counterparts by having majored in physics as undergraduates. Their educational background as well as other characteristics of the graduate astronomy population are presented in **Table XIV**, which has a format similar to that of **Table I** to facilitate comparisons with the graduate physics population. Traditionally, astronomy has always attracted a larger proportion of women and fewer foreign students; the 1984–85 survey indicates no changes along these lines. Examining the sources of support and student status of the first-year students, we find that a higher proportion of astronomy students held research assistantships and study on a full-time basis.

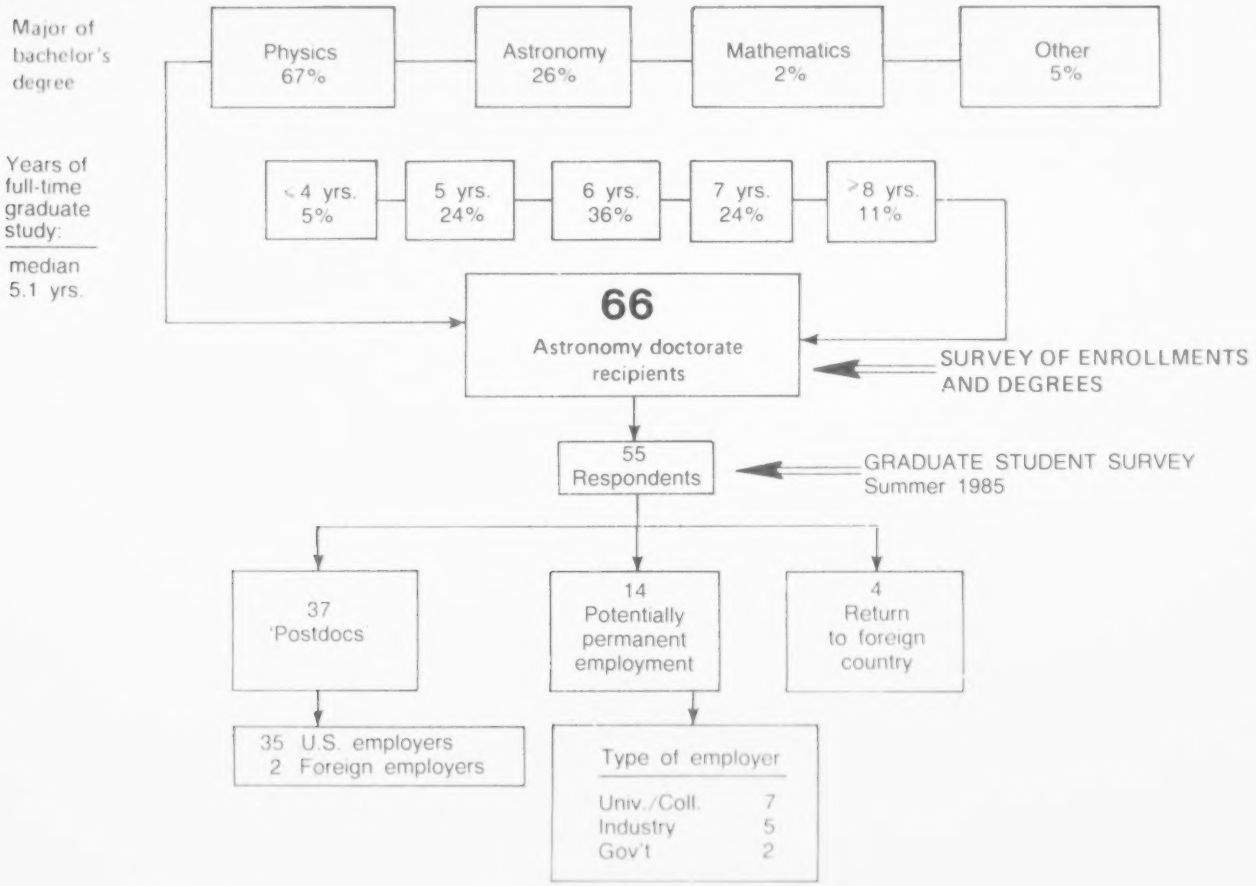
Table XIV. Characteristics of the graduate astronomy student population, 1984–85.

Characteristics		All graduate students	First-year graduate students	Doctorate recipients
	*Total population:	716	151	66
	Number of respondents:	406	80	55
Sex	Female	19%	25%	13%
	Male	81	75	87
Citizenship	U.S.	78%	72%	89%
	Foreign	22	28	11
High School Physics	Yes	92%	92%	93%
	No	8	8	7
Major of bachelor's institution	Astronomy	34%	36%	26%
	Physics	59	56	67
	Mathematics	3	4	2
	Other	4	4	5
Type of bachelor's institution	PhD-granting	60%	53%	69%
	MS-granting	4	5	2
	BS/BA-granting	15	16	19
	Foreign	21	26	10
*Type of graduate institution	PhD-granting	97%	93%	100%
	MS-granting	3	7	–
*Student status	Full-time	94%	97%	92%
	Part-time	6	3	8
Source of support	Teaching assist.	27%	50%	14%
	Research assist.	50	23	65
	Fellowship	14	15	12
	Family, savings, loans	3	5	4
	Other	6	7	5
Major subfields	Cosmology	26%	29%	27%
	Interstellar matter	15	14	20
	Solar system	7	7	4
	Stellar atmos. & spect.	19	10	20
	Astrophysics	9	13	8

**These data were reported by astronomy department chairpersons as part of the Survey of Enrollments and Degrees.*

Note: Only 16 terminal master's degrees were granted and 9 responses received.

Figure V. Background characteristics and post-doctorate status of 1984–85 astronomy graduates.



By comparing the time required to complete an astronomy doctorate with that required by physicists, we find in **Figure V** that only 11% spent at least eight years of graduate study whereas 16% of the physicists required eight years or longer.

To add to the characteristics presented in **Table XIV Figure V** shows the postdoctorate employment status. As in past years a majority of the graduates accepted 'postdocs', two of which were offered by foreign employers to U.S. citizens.